DEEP-SEA FISHES OF THE BERMUDA OCEANOGRAPHIC EXPEDITIONS

INTRODUCTION*

By William Beebe

§ The value of these contributions to the ecology of deep-sea fish lies chiefly in the fact that the specimens concerned were all taken in thirteen hundred and fifty nets, drawn in one locality. This locality is an eight-mile circle, with its center at 32° 12′ North Latitude, and 64° 36′ West Longitude, nine and a quarter miles south-south-east of Nonsuch Island, Bermuda. Vertically, this is an imaginary cylinder, considered as extending from the surface to the bottom of the sea, an extreme range of fifteen hundred fathoms. Further details as to locality, dates, methods of work and net data may be found in Volume XIII of Zoologica, on pages 1 to 45.

Important new physical data of this particular locality have recently been supplied by a special oceanographic station established by the research ketch Atlantis, of the Woods Hole Oceanographic Institution. In August 1931 it was in Bermuda and at my expressed wish, Dr. Henry B. Bigelow kindly allowed the Atlantis to make a station at the exact center of my area of exploration. Under the direction of Dr. H. R. Seiwell this work was carried out on August 27th, from 5:50 to 7:38 P. M. (1750 to 1938), in 32° 11′ North Latitude, and 64° 36′ West Longitude. The temperatures agree with those taken on several occasions by the Staff of the Zoological Society.

The following physical data were obtained:

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Depth			Temperature		Salinity	d+	0_2 cc/L	PH	PO_4 M_9/M_3
Meters	Fathoms	Feet	Cent.	Fahr.					
0	0	0	28.10	82.6	36.50	23.52	4.5	8.45	12
25	13.6	81.6	28.02	82.43	36.45	23.51	4.5	8.49	12
50	27	162	21.77	71.2	36.61	25.53	5.5	8.46	12
100	54.6	327.6	19.02	66.25	36.59	26.24	4.9	8.46	12
200	109	654	18.24	64.8	36.555	26.42	4.8	8.45	14
300	164	984	17.93	64.3	36.50	26.46	4.7	8.41	15
400	218.7	1312	17.30	63.1	36.40	26.54	4.4	8.39	19
600	328	1968	14.47	58	35.91	26.80	4.3	8.23	26
800	437	2622	10.27	50.5	35.35	27.20	3.4	8.11	49
995	544	3264	6.76	44.2	35.075	27.53	4.3	8.10	47
1194	653	3918	5.29	41.5	35.08	27.72	5.2	8.08	46
1593	871	5226	3.96	39.1	34.99	27.81	6.0	8.06	45
1993	1089.8	6539	3.54	38.4	35.04	27.89	6.0	8.15	46
2492	1362.6	8176	3.205	37.8	34.965	27.87	5.9	8.08	48

Depths at 200, 400, 800, 995, 1593 and 1993 meters by unprotected thermometer.

Position of Fishawk Snapper Sample: 32° 10′ 53″ N. Lat., 64° 36′ 57″ W. Long.

§ The following methods of procedure require special comment:

MEASUREMENTS:

Length: All measurements of length refer to standard length (snout to base of caudal fin) unless otherwise specified.

Eye: The eye diameter is the greatest external width of the eyeball, as the deeply pigmented iris is frequently shrunken and the whole eye enclosed in a thick, transparent capsule in the Alepocephalidae and Bathylagidae.

Interorbital: The interorbital breadth is measured between the bony, interorbital ridges at the *plane through the middle of the eye.*

Interocular: The full width between the external free margins of the thin, lamella-like supraorbital expansions of the frontals, *at the plane through the middle of the eye.*

Stomach: Unless otherwise specified, the stomach is measured from the anterior end of the intestine to the tip of the blind sac, due to the frequent lack of any sharp demarcation between the oesophagus and the stomach proper.

DEVELOPMENT: In an attempt to work toward a uniformity of terminology and a ready means of classification of deep-sea fishes in various stages of development, the following stages are recognized, defined in general as follows:

Larva: Fish entirely free of egg membranes but with remains of yolk sac present, or with intestinal tract lying open externally along the ventral profile, not enclosed within body cavity.

Post-larva: No yolk sac; intestine (except protruding posterior tip) enclosed within body cavity.

Rays of paired fins only partially differentiated.

Ossification lacking, or with traces in head only.

Adolescent:

Rays of paired fins fully differentiated, though usually unossified.

Ossification incomplete.

Gonads immature.

Adult: Ossification complete.

Gonads fully developed.

In the various species the stages are usually well defined by differences of proportion, pigmentation, dentition, etc. in addition to the basic distinctions just listed. The differences between larva and post-larva are in general more pronounced than those between succeeding stages.

The change from one stage to the next is, of course, gradual, and transition forms frequently occur, distinguished by vestigial characters of the early stage combined with partially developed traits of that succeeding. Although these transitional specimens are in some cases closer to the later than the earlier stage, for the sake of uniformity they are always counted with the earlier stage in all totals where they are not separately named.

ECOLOGY: Due to adverse weather conditions the total numbers of nets drawn, during the months of the three trawling seasons from April through September, were not equal. Thus in September, between 400 and 1000 fathoms, six times as many nets were drawn as in April, nearly twice as many as in May, and so on. In order to determine what difference an equal chance each month of catching specimens might make in the total monthly numbers, the following procedure was followed: The sum of the specimens taken over the three-year period during the same month was multiplied by the quotient of the total number of nets drawn (between the limits of

the species' Bermuda vertical distribution) during September, the month of maximum number of hauls, divided by the total number drawn during that month between the same depths. Thus, in July during 1929, 1930 and 1931, 20 specimens of *Bathylagus glacialis* were taken. The vertical range of the species off Bermuda is from 500 to 1000 fathoms. Altogether 178 nets were drawn in July between these depths, while 288 were pulled during the three Septembers. Therefore, 20 is multiplied by 1.6, giving a product of 32, the total number of specimens that theoretically would have been taken had the maximum number of nets been drawn in July. The dotted lines on the graphs of seasonal distribution represent the result of these computations, *always, of course, accompanied by the solid line of actual results.* In general, the relative result, for purposes of drawing distributional conclusions, is very little changed.

The total numbers of nets drawn at the depths from 500 to 1000 fathoms are practically identical as may be seen from Zoologica, Vol. XIII, No. 3, p. 37. At 400 fathoms, however, only one-third as many nets were drawn. For this reason, on the graphs of vertical distribution 400-fathom-totals have been multiplied by three and this theoretical result indicated by a dotted line above the *solid line which represents the actual totals.*

In working out the limits of the vertical distribution of the various species throughout the world from previously published records, the possibility of the capture of specimens in the course of hauling in the net has been ignored. Where specimens were taken in vertical nets the maximum depth is used.

In calculating the average depths and lengths of the Bermuda specimens, standard deviations have been disregarded, as they were found to be too slight to be of any practical value.

The following arbitrary divisions are made in defining the abundance of a species:

Abundant: More than 30,000 specimens taken (Example, *Cyclothone signata*)

Plentiful: 1000 to 3000 specimens taken (Example, *Myctophum laternatum*)

Common: 500 to 999 specimens taken (Example, *Sudis bronsoni*)

Fairly common: 100 to 499 specimens taken (Example, *Argyropelecus hemigymnus*)

Uncommon: 50 to 99 specimens taken (Example, *Bathytroctes rostratus*)

Rare: 15 to 49 specimens taken (Example, *Bathytroctes drakei*)
Very rare: 1 to 14 specimens taken (Example, *Dolichopteryx longipes*)

§ The Bermuda collection contains the following new genera and species:

ALEPOCEPHALIDAE:

Anomalopterus megalops Beebe 1933
Dolichopteryx binocularis Beebe 1932
Macromastax Beebe 1933
Macromastax gymnos Beebe 1933
Photostylus Beebe 1933
Photostylus pycnopterus Beebe 1933

LIST OF SPECIES

Family ALEPOCEPHALIDAE

Family ARGENTINIDAE

SUMMARY OF IMPORTANT POINTS

First Two Families

ALEPOCEPHALIDAE:

General: Prevalence of light organs of most varied types. Deep pigmentation of larvae and post-larvae. Great majority of Bermuda specimens immature.

Genera and Species:

Anomalopterus megalops: New species, with light organs. Second known specimen of the genus.

Bathytroctes drakei: A species known previously only from the type, taken by Beebe from Hudson Gorge in 1928. Full descriptions of young stages.

Bathytroctes rostratus: First record from western Atlantic. Discovery of biserial tooth stage. Evidence that light organs are limited to adolescent stage. First description of digestive organs.

Dolichopteryx binocularis: New species with scales and a ventral luminous organ. First description of the osteology of *Dolichopteryx.*

Dolichopteryx longipes: Discovery that specimens as small as 35 mm. are well ossified, almost ready for breeding. Digestive and reproductive organs described for first time.

Macromastax gymnos: New genus and new species which supplies a link between the scaled, *Bathytroctes*-like Alepocephalids and the tubercled, *Xenodermichthys*-like group.

Photostylus pycnopterus: New genus and new species with curious, stalked, light organs, and a striking resemblance in general form to a Melanostomid larva.

Xenodermichthys copei: Genus taken for second time in western Atlantic. Definite arrangement of light organs evident.

ARGENTINIDAE:

General: Occurrence of light organs in at least one species; luminescence previously unknown in family. Great majority of Bermuda specimens immature.

Genera and Species:

Bathylagus benedicti: Young specimens taken for first time. Most of these occurred in the spring, showing definite relation between length and season.

Bathylagus glacialis: First occurrence in western Atlantic; tends to have a very slightly smaller head and eye than eastern specimens and an extra pelvic finray. Young described for first time. Post-larvae have stalked eyes and definite pigmentation patterns. Adults and some adolescents have luminous abdominal scales and luminous bands on the anal and lower caudal; this not only alters the definition of the family, but at least partially refutes Günther's theory that they have enormous eyes to make up for their

own lack of luminous organs. Average depth found to be 100 fathoms higher in spring than in late summer and fall. Osteology described for first time in the genus. First description of digestive and reproductive organs and of eggs.

§ In the recording and correlation of the data of the present paper I have had the constant and invaluable assistance of Miss Jocelyn Crane, Laboratory Associate on my staff. Our work began with the specimens as they were taken from the nets, still living or just dead, and in the majority of cases, measurements and descriptions have been made before preservation.

All skeletons, as a whole or in part, are described from dyed and cleared specimens prepared by Miss Gloria Hollister, Research Associate, whose preparations have reached almost the acme of excellence.

The line drawings are by Mrs. Helen Tee-Van and Mr. Edward Delano.